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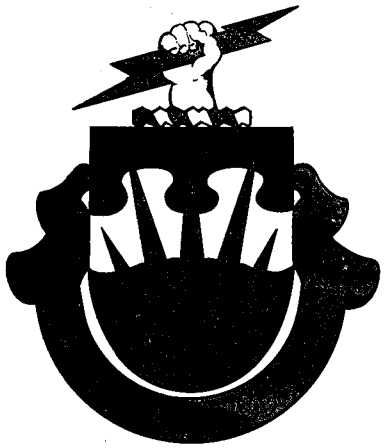

SCIENTIFIC HIGHLIGHTS.

2nd Quarter
1990

US Army Research Development and Standardization Group (United Kingdom)

BOX 65 - FPO NEW YORK 09510 - 1500

SCIENTIFIC HIGHLIGHTS

CONTENTS

EXECUTIVE SUMMARY

This publication is arranged so that the significant activities of our organization can be gleaned by the busy executive by reading the Introduction of this report, and the underscored portions of the subsequent sections.

FOREWORD

The major functions of the Research Division of U.S. Army Research, Development and Standardization Group (USARDSG-UK) are to identify and cultivate unique offshore technology and to transfer it to the U.S. Army's research laboratories and agencies. In order to make that transfer of technology more timely and effective, we provide, in the Scientific Highlights, information on the significant activities and accomplishments of the Research Division on a quarterly basis.

Further information on the activities and accomplishments of the Research Division is available in the USARDSG-UK Research Activities Report and the U.S. Army Research Office Annual Report. If you are not now receiving these publications, but would like to, please contact the undersigned. Comments or questions regarding items appearing in any of these publications may be addressed to the point of contact given in code at the end of each article and defined in the following pages.

Every year USARDSG-UK sponsors select international conferences relevant to the U.S. Army's Research and Development program objectives. In return, waivers of registration fees for a few scientists who participate from the U.S. Army Labs are allowed. A list of conferences to be held in FY90 is included in this issue. To avail this concession, the incumbent participant should contact the relevant responsible scientist at the USARDSG-UK as early as possible. Similarly, information about the planned workshops is included. These workshops are an excellent forum to discuss ongoing work and to transfer information between foreign and U.S. Army scientists. Researchers, active in the area covered by these workshops, are encouraged to take steps to participate in them. Usually one or two scientists from the U.S. Army laboratories participate by presenting papers or discussions at each workshop. USARDSG-UK will help as much as possible in facilitating participation in these conferences and workshops.

So that we may make this publication more effective in the future, we would appreciate feedback from you, the readers. We welcome your comments and suggestions.

C.C. SMITH
COL, CM
Commanding

INTRODUCTION

The United States Army Research, Development and Standardization Group - United Kingdom (USARDSG-UK) has both research and standardization missions. The research mission is carried out by the USARDSG-UK's Research Division, historically known as the U.S. Army European Research Office (ERO). It is with the activities of the Research Division that this brochure is concerned.

The Research Division is basically an extension of the U.S. Army scientific community into Europe, Africa, the Middle East, and South West Asia. The technical staff consists of senior scientists and engineers who collectively represent a very broad range of disciplines: chemistry, biology, physics, mathematics, material sciences, aeronautics, mechanics, electronics, and computer sciences. Each of these groupings of disciplines is covered by a staff scientist from the U.S. Army Research Office (ARO). Additionally, staff scientists from the U.S. Army Corps of Engineers and the Army Research Institute (ARI) are administratively attached to USARDSG-UK; they cover: respectively, environmental sciences and behavioural and social sciences. Names and telephone numbers of these scientists are given in a subsequent section.

The research mission is implemented by:

1. Acting to encourage the most effective possible exchange between the scientific and engineering communities of Europe, Africa, the Middle East, and South West Asia, and the scientists and engineers in the U.S. Army research laboratories and agencies; and

2. Encouraging and supporting basic (or fundamental) research which is unique in character and highly relevant to the interests of the U.S. Army.

The former aspect of the mission is accomplished chiefly in four ways: a) technical staff visits to universities and other research activities with resident personnel; b) technical staff attendance at international conferences, symposia, and workshops covering technical subjects of interest to the U.S. Army; c) under certain circumstances, by assisting European, African, Middle Eastern, and South West Asian scientists and engineers to visit appropriate U.S. Army research and development laboratories and agencies; and d) provide, on occasion, travel support for Army scientists.

The latter aspect of the mission is accomplished largely in two ways: a) by support of international conferences, symposia, and workshops, the workshops typically being highly focused on U.S. Army problems; and b) by support of unique research projects. Support of research projects may be accomplished using in-house funds provided by ARO or funds provided by U.S. Army laboratories and other DOD agencies.

In the sections that follow entitled HIGHLIGHTS OF THE RESEARCH PROGRAM and TECHNOLOGY TRANSFERS, we will present selected activities and progress during this period on projects, liaison travel, symposia, conferences and workshops. Selected technical and administrative items will often be presented in some detail. A listing of the board-approved contracts, as well as planned conferences and workshops sponsored by Research Division will be provided.

POINTS OF CONTACT

Listed below are points of contact for inquiries about items appearing in this publication or about other technical/-scientific matters regarding this office. (FAX: 44-71-724-1433)

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PLEASE NOTE, AFTER 6 MAY 1990, THE LONDON AREA CODE CHANGED FROM 1 TO 71

II. HIGHLIGHTS OF THE RESEARCH PROGRAM

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SYNTHETIC APPROACHES TO TAT

The prospects are bleak for finding new synthetic approaches to TAT (tetra-acetyl tetrazocane), which is a relative of HMX. This is the conclusion of Professor H. Wamhoff at the University of Bonn, FRG. He recently submitted his final report on the subject which summarizes a wide variety of attempted syntheses and transformations with little or no success. His conclusions are summarized below.

Almost all experiments revealed that the development of a novel route to TAT and related molecules, which might successfully compete with the few useful procedures known today, is indeed very difficult and limited to a narrow selection of reactions. The weak stability of the 8-membered [8]ane-N_4 systems seems to play the decisive role. All approaches which need more vigorous and energetic reaction conditions do not normally result in the desired 8-membered ring system; but instead, decomposition products and/or polymeric material result from these experiments.

On the other hand, ring synthetic approaches, even under template conditions, turn out to be successful only when the final [8]ane-N_4 product is internally stabilized, e.g. by amide resonance. As soon as one tries to chemically modify these internal stabilization elements, the heterocyclic system shows a total collapse, and decomposition products, as well as polymers, are the only result.

In this and in the earlier research project, a vast number of experiments have been investigated, with the aim toward approaching the TAT target molecule from as many sides as possible. Unfortunately, none of all those well thought out proposed routes brought a definite breakthrough. In summary, at the moment there is no comparatively simple and economic access to TAT in sight.

The Final Report will be available from DTIC in the near future. (Chemistry and Biological Sciences Branch).

CHARACTERIZATION OF A GLUTAMATE RECEPTOR

Professors Usherwood (Nottingham) and Barnard (Cambridge) report very good progress in their Fourth Interim Report on contract DAJA45-88-C-0032 entitled "Structural and Biophysical Characterization of a Glutamate Receptor".

Until this work, it was generally believed that glutamate receptors which are not activated by N-methyl-D-asparate (NMDA) form a major class comprised of two well-recognized

types, those activated by kainic acid (KA) and those activated by quisqualate (QUIS) or its more selective homologue AMPA (-amino-3-hydroxy-5-methylisoxazolepropionate). They first sought to purify the KA receptor, using the brain of Xenopus where it is exceptionally abundant. Surprisingly, it was found that both the KA binding sites and the AMPA binding sites present in Xenopus brain membranes can be coextracted by octylglycoside and shown to behave as one entity in all analyses made in solution. Furthermore, when partly purified by lectin affinity, ion-exchange chromatography or by sucrose density centrifugation, the two activities comigrate in a 1:1 ratio. There are equivalent numbers of AMPA and KA sites and the two sites show a single affinity series for the binding of the glutamatergic agonists. They deduce that KA and AMPA (or QUIS) select different conformations of a single KA/AMPA receptor binding site, thus perhaps explaining the different channel-opening events that have been reported by others for these two agonists.

The pure receptor protein was obtained by affinity chromatography, and several subunits were found on SDS PAGE and in chromatofocussing, these were associated with both binding activities. All the evidence obtained from the pure receptor indicated that it was a single protein (containing several subunits) which possesses both the KA and the AMPA (or QUIS) sites. While this work was in progress, and after the publication of the first part of it, a report appeared in Nature of a cDNA encoding a KA binding protein from another amphibian (Rana) (See Wada et.al., Nature 342, 684 (1989)). The proteins are considerably different in the following ways:

a. The Rana protein, as obtained by purification or by cloning, has only the KA sites, not the AMPA sites.

b. The Rana protein had only one type of subunit (48K Mr) whereas several were found here.

c. The Rana protein does not give receptor channels. The Xenopus protein gives characteristic KA and AMPA receptor channels when reconstituted.

It appears possible that the preparation from Xenopus, which is different and gives greater protection from proteolysis than that used for Rana, preserves the other subunits which may be degraded in the Rana preparation, losing function but retaining only the KA-binding (non-receptor) protein.

Barnard and Usherwood have been able to successfully reconstitute the receptor into artificial bilayers, and the receptor shows activity (i.e. channel openings were observed) on exposure to KA or AMPA.

The peptide sequences obtained for the Xenopus unitary receptor were used to construct DNA primers, which were used

in the polymerase chain reaction (PCR) to yield an 850 base fragment which has now been fully sequenced and will be used to screen libraries of cDNA.

The future main objective will now be to obtain full length cDNAs encoding subunits of the insect non-NMDA receptors of the nervous system. This may avoid the problems found by the workers with vertebrate clones, where functional expression of the cDNA was poor or lacking altogether. The insect cDNAs will then be characterized and expressed. Each will be transcribed to RNA, expressed in the Xenopus oocyte, and the channel forming ability and properties will then be characterized.

This research on the gluamate receptor will be invaluable to other investigators in Biotechnology and especially to Army programs on the use of receptor arrays for generic detection of physiologically active chemicals. (Chemistry and Biological Sciences Branch).

DEVELOPMENTS IN NONLINEAR FILTERING AND APPROXIMATION TECHNIQUES

This research deals with theoretical and numerical aspects of stochastic differential systems with noisy measurements, applicable to the modelling of nonlinear filters. Filtering techniques are critical for obtaining state space information of nonlinear systems from measurements with errors, hence they are important in signal processing and nonlinear control. The research group at INRIA (Sophie-Antipolis, France) lead by Professor Etienne Pardoux, has recently made advances in stochastic DE's on several fronts. For one-dimensional systems with piecewise linear coefficients and which satisfy certain detectability hypotheses, an efficient approximate filter can be constructed from Kalman filters associated with the linear differential systems corresponding to the individual linear components of the coefficients. They have also shown the consistency of the maximum likelihood estimator (MLE) for unknown parameters in a stochastic differential system with asymptotically small noise. Using the theory of large deviations, they prove that the limiting points of the MLE sequence are minimizers of a least-squares type functional for the estimation of the parameters in the deterministic system obtained by zeroing the noise terms. Finally, they are currently investigating a numerical time discretization technique for solving the Zakai diffusion equation corresponding to a filtering problem with correlated noise. This equation arises in computing likelihood functions in parameter estimation. The technique they are studying is a predictor-corrector (well known in deterministic differential equations) scheme on semigroups. They show the convergence order of the method to be 1/2 (in powers of the time step) which is optimal for this equation. (Mathematics and Physics Branch)

IMPROVEMENT IN THERMOELECTRIC POWER GENERATION EFFICIENCY IN SEMICONDUCTOR ALLOYS

Research is being carried out on silicon germanium - gallium phosphide alloys in order to improve them for thermoelectric power generation. The Jet Propulsion Laboratory has reported that a high temperature anneal of this alloy improves its electrical power conversion factor. However, recent findings of Dr. Rowe of the University of Wales, Cardiff, and his associates have shown that this conversion efficiency keeps improving as the material is cycled through high and low temperatures a number of times, possibly reaching a saturation limit eventually. They have also seen microstructural changes accompanying this improvement. Further microscopic diagnostic studies are planned to pin down the underlying fundamental causes and dynamics that are responsible for the observed improvement with an eye towards eventual introduction of these improvements into actual operational devices. (Mathematics and Physics Branch)

MAGNETO-TRANSPORT STUDIES OF InSb-CdTe HETEROJUNCTIONS

Professor M. Pepper at the University of Cambridge, UK, has been investigating topics in solid state physics relating to future electronic devices. His research has been supported by the USARDSG-UK and the U.S. Army ETDL. Recently, he has reported on the results of magneto-transport studies of InSb-CdTe heterojunctions.

The III-V semiconductor InSb possesses a narrow band-gap (E_g=0.236 eV at 4.2 K) and small electron effective mass, leading to very high electron mobilities (~5×10^5 $cm^2V^{-1}s^{-1}$ at 77K). It is also closely lattice-matched to the wide-gap II-VI semiconductor CdTe(E_g=1.6 eV at 4.2K) permitting the fabrication of InSb-CdTe heterostructures. A two-dimensional electron gas (2DEG) of electrons of a small effective mass and high mobility is confined in InSb quantum wells deeper than the InSb band-gap. InSb-CdTe heterojunctions are thus of considerable interest as semiconductor devices: for example, HEMT-type structures based on InSb-CdTe have been predicted to have an order of magnitude higher electron mobility than equivalent GaAs-(Ga,Al)As devices, whilst InSb-CdTe quantum wells are potential infra-red sources and detectors.

In Professor Pepper's laboratory, a series of magneto-transport measurements have been performed on specimens of InSb-CdTe heterojunctions containing a high-mobility (~22,000 $cm^2V^{-1}s^{-1}$), low carrier density (1.7-4.2x10^{11} cm^{-2}) two dimensional electron gas (2DEG). This combination has been realised for the first time as a result of improvements in molecular beam epitaxy growth techniques. Depending on the carrier density, one or two subbands are occupied, and at high magnetic fields the 2DEG exhibits both zeroes in the diagonal

magnetoresistivity and accurately quantised Hall plateaux. The low-field magneto-transport reveals the importance of a spin-splitting of the subbands, present even at zero magnetic field, due to a term proportional to K^3 in the InSb bulk Hamiltonian and the spin-orbit interaction in an asymmetric potential well containing a strong electric field: the splitting is found to be - 2 meV, and its size and dependence on the carrier density have been theoretically modelled within a triangular well approximation. Measurements of the g-factor have been carried out using high-field magnetotransport in fields tilted away from the normal to the 2DEG. These indicate that the g-factor in the heterojunctions is between 86 and 120, greatly enhanced over the band-edge value in InSb: the enhancement is far too large to be due to exchange effects.

These preliminary measurements have demonstrated that the InSb-CdTe heterojunction is both an interesting system in its own right, and an ideal tool with which to study effects specific to narrow-gap semiconductor space-charge layers. The advent of the improvements in growth techniques responsible for the samples in this study may lead to an upsurge of interest in this promising electronic material. (Electronic and Computer Sciences Branch)

ADVANCED TRIBOLOGICAL COATINGS FOR HIGH SPECIFIC STRENGTH ALLOYS

Under ERO contract DAJA45-87-C-0044, the National Centre of Tribology, Risley, UK, has been studying various coating technologies on tantalum alloy for rolling contact fatigue and pin-on-disk wear resistance. Coating structure and thickness was determined and a microhardness depth profile was measured. Reproducability and additional tests are underway. Results todate (6th Interim Report, 2 Apr 90) indicate nitrocarbarizing is superior to ion implantation, anodising, plasma nitriding, pack aluminizing and nitrox processes. (Material Sciences Branch)

ELECTRICAL IGNITION OF HAN-BASED LIQUID PROPELLANTS

This recently completed research effort by G Klingenberg of the Ernst-Mach-Institute, Weil am Rhein, West Germany had a principal objective of investigating means of electrical ignition of liquid gun propellant (LGP).

The feasibility of arcless ignition of LGP 1864 was investigated using vented chambers, and it was demonstrated in a small calibre RLPG simulator. The igniter consists of a center electrode separated from conically shaped vented outer electrode by a hollow cylindrical insulator. As far as

scaling up to larger calibres is concerned, the simplest strategy would be to build and enlarged version of the igniter. The main difficulties with this approach are the unknown ignition scaling parameters and the mechanical stability of the component parts. It may be easier to use an arrangement of igniters of the present type and size working in parallel to achieve the required performance. Another approach is a staging process in which the liquid propellant in the first stage is ignited electrically and subsequent stages are ignited from the reaction products and heat released from the preceding stage.

Simple electrostatic theory has proven to be a valuable tool for the optimization of the electrode and cavity geometries. Computer aided numerical calculations yielded an improved electrode geometry, which absorbs less electrical energy and requires less charge voltage than the earlier designs. Apart from the overall geometry, the energy consumption of the ignitor is determined mainly by polarity, electrode surface area, anode/cathode area ratio, and charge voltage. High-speed emission and transmission films taken during the ignition process indicate a chemical ignition mechanism. Ohmic heating and/or electrochemical conversion are not in themselves sufficient to force ignition by way of the primary decomposition products. The very long ignition delays encountered with the EMI-AFB ignition test fixture imply that additional reactive intermediates are necessary.

Scanning electron microscopy (SEM) and x-ray microanalysis show that ignition is affected by the chemical and physical characteristics of the electrode surface. Corrosion and wear of the steel presently used were considerable. A uniformly smooth surface reduces ignition delay and energy transfer to the liquid propellant. Preliminary results of IR spectrometric monitoring of combusting liquid propellant demonstrate the applicability of the method as a diagnostic tool. The species resolution is lower than that of Gas Chromatography/Mass Spectrometry, but temporal resolution is more easily and non-intrusively achieved. (Aeronautics and Mechanics Branch).

DEFORMATION, FRACTURE AND EXPLOSIVE PROPERTIES OF REACTIVE MATERIALS

This recently completed research effort by Dr. J.E. Field, Cavendish Laboratory, University of Cambridge, U.K. investigated the behavior of explosives when impacted. A number of techniques were used in the studies. They included a drop-weight facility with transparent anvils, an instrumented dropweight machine, a miniaturised Hopkinson bar system for high rate of strain property measurement, laser speckle for studies of deformation and fracture of PBX's, and automated system for analysing speckle and moire records, and a

heat sensitive film technique for recording the position and temperatures of "hot spots". Data is presented on the behavior of a range of HMX's of different particle sizes, TATB, PBX's based on TATB and various propellants when impacted in the drop-weight test. The propellants were studied both at room temperature and below their glass transition temperature. At the lower temperature their flow stresses were higher and in the main they were more sensitive. Photographic evidence is presented of adiabatic shear band formation: measurements of band spacing and band width are compared with theoretical predictions. Continued development of speckle and moire techniques and their application to deformation, impact and fracture studies are described. Research on the propagation of reaction down columns of pressed explosive and of shock/cavity interactions was outlined. (Aeronautics and Mechanics Branch).

WORKSHOP ON UNSTEADY AND TWO-PHASE FLOW

The Aeronautics and Mechanics Branch sponsored an international workshop entitled "Unsteady and Two-Phase Flows". The workshop was organized by Professor J.H. Whitelaw and held in the Mechanical Engineering Department of Imperial College, London, U.K. on 28 and 29 June. The workshop was attended by 35 participants from eight countries. The technical program comprised four sessions with two concerned with Unsteady and Two-Phase Flows and the other two with Gun Flows. A total of 22 formal presentations were made with extensive discussion.

An observation is the flexibility and accuracy of calculation methods when applied to sprays and mixing regions, where measurements and calculations are in close accord. There is a need to extend the application of these methods to complex unsteady flows, including those in gun-barrel configurations. This should be undertaken in a step-by-step manner in which the methods are applied first to complex breech-type geometries and then to two-phase flows where the concentration is increased progressively to that of real guns. Calculated results for combusting flows was presented, including those with spontaneous ignition, and this type of work should be extended in terms of related experiments.

Those papers concerned with interior ballistics represented a spectrum of activity ranging from non-combusting gas guns to 60 mm calibre with real propellant charges. As expected, local-flow results are available from the former and only wall results from the latter. Consistent with the previous comments, there is a need to extend knowledge of in-cylinder flow to include local flow characteristics, including velocity, temperature, particle size and species concentrations as functions of time and position. In prac-

tical terms, this type of information should be acquired in a gas fun with increasing concentration of solid propellant. Only in this way will understanding of wall-erosion and heat-transfer information be available in a way which will assist the design of more complex systems.

The experimental techniques required to fulfill the requirements of the topics mentioned above are available only in part. Methods for the measurement of erosion and wall temperature were reported at the workshop and, although questions can be raised about time resolutions in excess of 10kHz, adequate methods are available if carefully used. The only methods for measuring local flow properties are based on light and must be limited to modest concentrations of propellant. Laser velocimetry provides a basis for velocity measurement, two-color pyrometry for temperature and the intensity of Doppler signals for particle size. The first method can contribute now with acceptable accuracy, but the latter two require development and more careful assessment of related uncertainties. Research work is necessary and further understanding of gun flows will not be achieved without it.

The calculation methods must be developed with particular care assigned to the achievement of numerical accuracy. The three presentations of numerical method made this very clear as a first priority. The solution of unsteady forms of the Navier Stokes equations with diffusion in two directions may be inefficient in much of the flow region but, in the long term, it may be justified. Interactive procedures are, however, worth pursuing since invisid and boundary-layer equations are representative of much of the flows in barrel and can be solved efficiently and accurately. Turbulence models will become increasingly important as the calculation methods begin to resolve the near wall flows and present two-phase flow models will prove to be decreasingly satisfactory as related measurements become available. (Aeronautics and Mechanics Branch).

III. TECHNOLOGY TRANSFERS

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VISIT TO THE UNIVERSITY OF HAMBURG

Dr. Mikael Ciftan visited the Hamburg Synchrotron Radiation Laboratory (HASLYB), where the synchrotron radiation from the DESY high energy physics machine is used for conducting experiments in condensed matter and atomic physics. He met with Professors Kunz, Matrelik, Sonntag, and Moller. A major finding was that they can now focus X-rays down to 1 micron resolution (and in the future anticipate resolutions of .1 micron), and the intensity is so high that they need only 1 millisecond or less exposure to look at structures of materials. They can probe the dynamics which occur at the macromolecular level, even in biological materials, and can make a movie out of these exposures. They are now able to study the minutest amounts of material, on the order of nanograms of matter, thereby eliminating the need for neutron scattering-type analysis, which requires a lot more material in order to get a good signal-to-noise ratio. They are able to study dislocation dynamics and other microscopic dynamic phenomena by focusing the beam on the surface of the material exactly on a single defect. This capability, together with the scanning tunneling microscopy that has recently been discovered, gives scientists extremely powerful tools to study the local microscopic dynamics of a great many materials.

Dr. Ciftan also visited the Chemical Physics department at the University of Hamburg, where Professor Otto Stern had done his famous experiments on the spin of the electron, thereby unraveling a very important cornerstone of Quantum Theory. He met with Professor Dr. Walter Gunsser, whose group has been doing work on atomic clusters that actually exist as defect clusters in alloy materials. They have been able to investigate the properties of these clusters by using Mossbauer spectroscopy in conjunction with several other methods. The research indicates that it may be possible, for example, to control the bulk magnetic properties of magnetic materials by controlling the size and distribution of the magnetic atom clusters in host materials. This is reasonable to expect, partly because the host atoms in their particular crystalline structure can influence the "surface" atoms of the clusters. This interaction can then thermodynamically determine the final configurations (bonding and coordination) between the cluster and host. The added freedom of controlling these interactions may offer us the possibility of yet another class of artificially structured man-made materials. (Mathematics and Physics Branch)

VISIT TO THE UNIVERSITY OF YORK

Dr. Ciftan visited with members of the Physics department at the University of York, specifically the department chairman, Professor J. Matthew. They discussed the physics of photoionization, particularly the "Giant Resonances" that are observed in many cross-sections. Dr. Ciftan intends to follow up on this subject with his PI's in the USA in order to find out how important such excitations might be in the modelling of cross-sections that are vital in nuclear effects applications relevant to ongoing work at HDL. Dr. Ciftan also found out that this department is working in the area of magnetic thin films. He has been developing a program in this area of research with several applications in mind, particularly non-reciprocal devices in the millimeter wavelength region. (Mathematics and Physics Branch)

RESEARCH ON LUMINESCENT FILMS

Professor A. Vecht of the Thames Polytechnic University in London, has been performing research on alternating current electroluminescent (ACEL) thin films. This work has been funded by U.S. Army Electronics Technology and Devices Laboratory (ETDL) as part of their program on large area display panels and has been administered by the Electronics Branch of ERO. The main objective of this research has been to investigate novel chemical vapor deposition growth techniques for producing high quality ACEL films based on Mn doped ZnS compounds. After several unsuccessful attempts, Professor Vecht has recently discovered a new method, involving evaporated interlayers of manganese, that has yielded very promising results. The films produced by this method have shown very high luminescence levels and may be suitable for actual device applications. Professor Vecht has provided samples of complete EL stacks using these films to ETDL for further test and evaluation. The next stage of the research would be directed toward the development of multi-color ACEL thin films using this method. Such films would find wide-spread application in Army systems involving color display panels. (Electronics and Computer Sciences Branch)

LIAISON TRAVEL TO US ARMY ETDL

Dr. K.A. Shore from the University of Bath, UK, made a visit to the U.S. Army Electronics Technology and Devices Laboratory (ETDL) to present a technical seminar concerning his current research. The title of his seminar was "Nonlinear Waveguides in Multi-Quantum Well Semiconductors." In his talk, Dr. Shore outlined the optoelectronics research at the University and described in detail the nonlinear optical properties of various multi-quantum well semiconductor waveguides. His research is centered on theoretical results of

waveguide structures incorporating a defocussing nonlinearity associated with the fundamental band-edge absorption in semiconductors. His visit to ETDL was hosted by Dr. M. Dutta, who is presently engaged in similar research cooncerning semiconductor waveguides. The seminar was well received and stimulated a number of interesting questions. Afterwards, Dr. Shore visited Dr. Dutta's lab and met with other researchers at ETDL. Possible collaborative projects were discussed, including optical interconnects for optoelectronic circuits and novel materials (organics, etc.) for optical waveguides. The Electronics Division at ERO provided financial support for this visit. (Electronics and Computer Sciences Branch)

EUROPEAN PARTICIPATION IN ARO'S U.S./JAPAN CONFERENCE ON SMART MATERIALS

Through the ERO liaison travel progra, two European scientists participated in the 19-23 March 1990 ARO conference on smart materials by presenting technical papers and contributing to discussions of position papers. Smart/intelligent materials, structures and systems generally consist of a material with imbedded or intrinsic sensors, some logic or control function, and a response action. For example, a smart satellite structure detects vibration, calculates damping action required, and drives piezoelectric actuators to eliminate unwanted vibration. Smart materials often mimic biological systems. Dr. Julian Vincent, University of Reading, UK, presented a very interesting and entertaining paper on "Insect Cuticle as an Archetype Composite Material", and Dr. K.H. Hoffman, University of Augsburg, Germany, presented a paper on "Mathematical Modeling of Dynamical Transformations in Smart Materials". The Director of ERO, Dr. W.C. Simmons, chaired one of the sessions. (Material Sciences Branch)

DODDS JUNIOR SCIENCE AND HUMANITIES SYMPOSIUM

As in the past several years, the scientists of the European Research Office, USARDSG-UK, have contributed their time and energies into evaluating and selecting final student research papers to be orally presented, and others by poster session, at the Department of Defence Dependent Schools, DODDS, Junior Science and Humanities Symposium to be held in Munich on 8, 9 and 10 March 1990. Senior (and Junior) high school students from American, British and Canadian dependent schools may participate. After initial screening by DODDS staff, about 65 research projects were evaluated by ERO staff. Many of the papers exhibited very high standards of approach, design, understanding and technical presentation. It was a pleasure to participate in the evaluation process, and to encourage student interest and initiative in the sciences and humanities. (Material Sciences Branch)

RSRE, MALVERN, UK, SCIENTIST STUDIES "TWO MICRON DIODE-PUMPED LASERS" WITH CNVEO LABORATORY IN VIRGINIA

Dr. M.J.P. Payne from the Royal Signals and Radar Establishment spent a very profitable seventeen weeks at the Center for Night Vision and Electro-Optics last summer and Fall 89, and was coordinated through the ERO liaison program. His recent Trip Report describes attempts to lay a basis for further research into high power, pulsed, diode-pumped lasers emitting in the spectral region near two microns. Various oxides and fluorides doped with trivalent Er, Tm and Ho were studied. The erbium-thulium energy transfer rates were studied in detail. In a general calculation, the population inversion threshold in both transversely and axially-pumped lasers was found to be independent of most of the crystal characteristics, and the details of the geometry. This invariance of a major component of the lasing threshold does not appear to have been recognised previously. It should make experiments, and lasers, easier to design but has yet to be tested in practice. (Material Sciences Branch)

BIOTECHNOLOGY IN THE SOVIET UNION

The following article is the summary of a one day Symposium that was held in London in December 1989. It covers the presentations that were made by the members of a British team of Biotechnology experts who visited several Research Institutes in the Soviet Union in late September 1989. Although the team did not visit any military centers, their comments and insight about the state of Biotechnology in the Soviet Union may be useful to other analysts.

INTRODUCTION

The invitation to visit the Soviet Union came from Professor E.D. Sverdlov, Director of the Institute of Molecular Genetics in Moscow. He had been the leader of a Soviet Delegation that had visited several British Biotechnology centers in July 1989. The Soviets were pleased with their visit to British Companies and Government Organizations and they welcomed a reciprocal visit.

The Chief Engineer and Scientist, Dr. Ron Coleman, of the Department of Trade and Industry (DTI) suggested that the visit could be a DTI Overseas Science and Technology Expert Mission (OSTEMS). Consequently, an OSTEMS was arranged. The general objectives of OSTEMS are to access offshore technology and markets, and to disseminate the scientific and technical information inside the UK as widely as possible; to explore the potential for cooperation and coordination; and to enable UK Industry, Government, and Academia to increase their

awareness of foreign achievements through direct contact with key organizations and people in their subject areas.

On behalf of the Center for Russian and East European Studies (CREES), University of Birmingham, the British Company, GB Biotechnology Limited organized the OSTEMS to the USSR for 15-28 September 1989. The Delegation had a broad spread of expertise representing Academia, Government, and Industry. The Institutes that were visited were among the leading ones involved in Biotechnology. Because of the busy schedules of the Delegates, additional visits to Institutes in Riga, Leningrad, Vladivostok, and Novosibirsk had to be turned down.

The Delegation team was comprised as follows:

Leader of Delegation:

Dr. Rod Greenshields, Managing and Technical Director. GB Biotechnology Limited, 4 Beaconsfield Court, Sketty, Swansea SA2 9JU.

Official Recorder:

Dr. Anthony Rimington, Research Fellow. The Center for Russian and East European Studies, Deputy Director, Professor Hanson. The University of Birmingham, Edgbaston, Birmingham B15 2TT.

Team Members:

Dr. Brian Richards, Chairman, British Biotechnology Limited and Chairman of DTI/SERC Joint Advisory Board for Biotechnology, Watlington Road, Cowley, Oxford, OX 45LY.

Dr. Ian Fleming, Consultant, DTI Biotechnology Unit, Laboratory of the Government Chemist, Building 216, Queens Road, Teddington, Middlesex,TW11 0LY.

Dr. Gwyn Humphreys, Academic Liaison, Celltech Limited, 230 Bath Road, Slough, Berks.

Dr. Shirley Lanning, Executive Director, BioIndustry Association, 1 Queens Gate, London, SW1H 9BT.

Dr. Harry Rothman, Director, Center for Science and Technology Policy, Bristol Business School, Cold Harbour Lane, Filton, Bristol.

OVERVIEW

The Delegation visited some of the most important basic research Institutes working in Biotechnology in the Moscow region of the USSR including the "BioCity" at Pushchino, and Kiev in the Ukrainian SSR. These Institutes ranged from those

primarily engaged in "pure" research, such as the Institute of Molecular Genetics (Moscow) or the Institute of Molecular Biology and Genetics (Kiev), to those which had strong links with industrial production, such as the Shemyakin Institute of Biorganic Chemistry, the most important and prominent Biotechnology Institute in the USSR. The Institutes varied considerably in size with the the number of staff ranging from two hundred to over one thousand people, although more than fifty per cent of these were reported to be support staff. This high percentage of support staff is common in Eastern Block research facilities where they are needed to make the equipment, chemicals, etc. that would be simply purchased by a similar laboratory in the West. The lack of hard currency precludes such purchases in the USSR.

The team found that a wide range of topics were under investigation including highly specialized work in molecular biology and genetic manipulation, as well as protein synthesis, transgenic organisms, and agricultural biotechnology. The quality of the work at the Institutes visited by the team appeared to vary considerably (not surprisingly). Some areas such as Professor Spirin's research on extra-cellular protein synthesis,at the Institute of Protein, Pushchino, had achieved widespread international recognition while in other areas, such as research on biosensors, work appeared to be less well developed. Lack of sophisticated equipment, except in the case of the Shemyakin Institute, particularly first class computers together with the lack of "hard" currency with which to purchase these were often cited as key factors in holding back development of high quality research. Nevertheless, in contrast to the situation existing in the UK, most Soviet Institutes possessed excellent services and large workshops with support staff as mentioned above, which helped to overcome problems caused by the lack of a well-developed indigenous technical equipment industry. The Shemyakin Institute of Bioorganic Chemistry in particular, was well staffed and equipped with a Pilot Plant (of Western manufacture) that was equal to any similar facility in the Western World.

It was found that senior staff spoke English and where an Institute was of International standing, most of the staff had a good working knowledge of English as well. Nevertheless, there was a clear requirement for a better exchange of information at all levels, even within the Soviet Union itself.

In the past, Institutes in the USSR Academy of Sciences were primarily engaged in basic research, and while some had industrial connections with Ministries, there was very little technology transfer. The Institute structure is common throughout the USSR and the centralized system of control has given the advantage of long-term stability and lack of financial concern. However this situation produced rigid management and paternalistic control especially for new developments

and awareness of international research.

From what was seen on this visit, it was concluded that the twin policies of Glasnost (openness), and Perestroika (restructuring), are changing this situation dramatically. A more flexible approach is emerging with the establishment of democratic relationships within the management structure and greater freedom of action for the Institutes. However, with this new-found freedom has come responsibility, especially with regard to financing. This is resulting in a strong technological 'push', with Institutes eager to market technologies which they have developed. Various routes for this are being exploited, from an Association of Biotechnology (MNTK "Biogen") that links academic Institutes to production centers. Joint ventures, Cooperatives (profit motivated ventures) and overseas links are also being used as avenues for marketing technology.

The team reported that it was clear from their meetings with Soviet scientists and technologists that they are as qualified and able as their Western counterparts but it was also clear that they are held back by the lack of the latest technological equipment, facilities, and insufficient internal and external contacts.

The team felt that there were commercial opportunities for UK biotechnology companies within the USSR while recognising that considerable effort was required to realise these. It was suggested that business with Soviet organizations could be carried out via joint ventures, or counter-trade agreements, although the potential does exist for direct involvement. Areas which appear to have promising commercial potential include the availability of R & D testing facilities for products registered in the USSR, and resource utilisation, such as marine and agricultural products. A wide range of biochemical, microbiological, and genetic engineering products were discussed with the team of visitors. These included DNA probes, culture media for animal cells, monoclonal antibodies, genetically engineered proteins and enzymes, pharmaceutical and antigens, test kits for bacteriological infections, gene sequencing and synthesising equipment, tritium counting equipment, processes for the production of specific biochemicals, and enzymes and coenzymes; in short virtually everything associated with Biotechnology.

The team concluded that the considerable changes that are occurring in the Soviet Union will stimulate interchange between the United Kingdom and the Soviet Union in Biotechnology in both the academic and the commercial world. Because of the complex nature of these changes and the vastness of the Soviet Union, problems in adjustment are being experienced by the Soviets, but given sufficient effort, a positive outcome can clearly be expected.

DELEGATION MEMBER's REPORTS

Each of the delegation members presented a report of their own impressions gained from visiting the Biotechnology related Institutes. These reports provide more detailed information about the work going on at the three major centers visited,Moscow, Puschino, and Kiev than the overview above, as can be seen from the following abbreviated reports from three of the team members.

Dr. Richards on The Soviet Science Base for Biotechnology

He reports that it is imperative for the Soviet Union to make use of all technology, both classical and novel to address the many serious problems in three main areas where biotechnology plays a role, namely, Agriculture, Health Care, and Environment. The science base has programs in all three areas although the visit tended to concentrate on the first two.

The Institute of Soil Science in the famous Biological Science City of Puschino, which lies 76km south of Moscow, has programs in most of the fundamental areas of Plant Science. These include Nitrogen Fixation, Photosynthesis and Photochemistry, Phytronics, Mineral Nutrition, Biomass, and Soil Restoration. The Director of the Institute of Protein Studies in the Science City is Prof. A. Spirin, whose work on ribosome structure and function in the 60's and 70's earned him respect and praise from the West. In addition to the advanced molecular biology programs which are a major focus of the Center, there were also applied projects in protein biosynthesis, xenobiological degradation, biomass generation, and search for bio-active compounds which indicate the importance of near term applications to the Soviets.

The Institute for Bio-organic Chemistry includes applied studies on physiologically active peptides, monoclonal antibodies, and the development of apparatus and computer applications. A striking example of near-term applications is that of cell-free biosynthesis of peptides which the Center plans to commercialise with industry. Puschino has permanent connections with the Ministry of Biological and Medical Industries to facilitate the technology transfer. Industry may now fund work at the Center but is not persuing such opportunities energetically.

The Institute of Biological Physics makes bacterial rhodopsin from halobacteria grown on a 10-15 liter scale. It produces collagen from fibroblasts on a variety of structural supports and is experimenting with keratinocytes in collagen-base artificial skin. These advanced projects are backed up by basic work on the cell, such as studies on ion channels, transport mechanisms, and receptors.

The Institute of Physiology and Biochemistry of Micro-organisms is directed by Academician Alexander Borokin. This Institute is the second most prestigious Institute of Microbiology in the Soviet Academy. Past interests have been in energetics and medical aspects of microbiology and single cell protein, but with recent environmental pollution creating concerns, the genetics of biodegrading micro-organisms is of current interest as is cellulose degradation. The rhizosphere and its influence on plant growth is also a major interest. This 25 year old Institute is being modernized with state-of-the-art fermenter packages of Western manufacture. In 1990, an international conference on Biotechnology and Ecology and another on Microbiological Degradation of Organic Compounds are being held, which emphasises the international importance of the work at Puschino.

In Kiev, two Institutes were visited which appeared to be the equal of their Moscow counterparts. The surrounding region of the Ukraine has a major part of the USSR's primary manufacturing capacity including that for Biotechnology. In the past ethanol production dominated, but with Peristroika, production of Single Cell Protein (SCP), and pharmaceuticals including antibodies and interferon are now in place. The work appeared to be highly advanced by any Western standards. The Institute for Bio-organisms, Chemistry, and Oil Chemistry (IBCOC) is a good example of the unusual combinations of scientific subjects that are sometimes found at the Institutes. Closer examination did reveal common technical approaches such as biosynthetic stereo-chemical synthesis were being used.

A major program at IBCOC is on amino-phosphonyls directed towards analogues of "Glyphosate", an agricultural herbicide that is used world-wide. Phosphorus stereochemistry is clearly a specialty. Their approach to separating racemates is to eliminate the unwanted isomers using steroespecific degrading enzymes. Another major interest is in halogen analogues of amino acids, e.g. difluoro methyl ornithine, for medical usage. Inhibitors of lipoxygenases and leukotriene analogues for medical and biological applications, total synthesis of cyclosporin by several novel routes involving methylated peptides, all illustrate the breadth of their Chemistry projects. The breadth of the molecular biology based projects at the IBCOC was also impressive. New simplified models for ATP synthesis, phosphorylated starches for high quality paper production, native and synthetic substrates and inhibitors for SAR analysis of thrombin, antigenic structure of potato viruses X&Y, and development of a new acellular Pertussis vaccine are all included. The Bio-engineering department collaborates with the Molecular Genetics Institute and the Agricultural Institute on subjects as diverse as model antibodies, insecticides against Colorado beetle, and antifungals.

The second Institute in Kiev that was seen was the large Institute for Molecular Genetics (IMG). Although one of the youngest institutes in the Ukrainian Academy, it seemed to be bursting with activity on a whole range of important topics, ranging from quantum biophysics through nucleic acid chemistry, cellular regulation, genetics and oncogenes, to bio-engineering. Several of their projects have novel approaches such as ribosome vectors for gene therapy, interferon production in a lambda phage, solid state biosensors, transgenic fish for production of bio-pharmaceuticals, large scale production of AMV reverse transcriptase enzyme, selective approaches to analysis of the human genome, and overproduction of pharmacologically active substances from plants (such as alkaloids comprising 2% of dry mass) by selection following chemical mutagenesis. The latter project has a particular value in the Soviet Union to save hard currency on supplies from the West.

Moscow undoubtedly has the most impressive institutes of the Academy. The Shemyakin Institute of Bio-organic Chemistry is remarkable in all its aspects: concept, people, building, and facilities. Western equipment abounds in its laboratories but it is the newly completed joint pilot plant for biological and chemical entities (at a cost of $45 million) that will be the envy of any institution in the West or East. Furthermore the Shemyakin has more hard currency available than most other Institutes (25% of the budget). This Institute was founded thirty years ago by Academician Shemyakin, and is now directed by Professor Ivanov. It employs 1500 people in the uniquely well-designed building in Moscow, and a further 300 people at Puschino. It plays a central role in Soviet biological science and also is a major training center. Most of the holders of Chairs in the State Universities were trained at the Shemyakin. The scientific programs include all the important fields in molecular and cell biology with special emphasis on immunology and low molecular weight bio-regulators including antibodies. Most impressive is the extensive work on membrane associated proteins and their functional role including light-sensitive proteins such as halobacterial rhodopsin for which they are close to a 6A X-ray structure.

Professor Sverdlov, Director ot the Moscow Institute of Molecular Genetics, has maintained his research team at the Shemyakin. His work on the structure of DNA-dependent RNA polymerase in the past, and current work on lymphokines to produce analogues by gene synthesis and site-directed mutagenesis is equal to anything in the West. The range and scope of relevant projects were amazing. They included studies on ATP-ase isoenzymes, Bacculovirus expression systems, Vaccines for Hepatitis A in vaccinia, Chimeric polio vaccine, and HIV vaccine; the latter to be shortly in clinical trial. Cloning of all the interesting epitopes of HIV proteins has been done in Bacculovirus and will shortly be in mammalian cells. The

Institute has close interactions with the Ministry of Medical Industries and the Academy of Sciences exemplified by clinical testing programs for interferon and other lymphokines both singly and in combination. The work seemed to be on a par with that in the USA in several areas.

Dr. Fleming on the interaction of Government, Industry, and the Science Base.

During the visits to the Institutes, a lot of time was spent listening to formal presentations by Institute Directors and staff leaving little time for laboratory visits and informal discussions. Thus a reasonable picture of the work of the Institutes may have been obtained, but only a general view of the interaction of Government, the Science base, industry, and the changes that are taking place can be given. The following is some information on topics of importance for the development of biotechnology in the USSR and the possibility of Anglo-Soviet collaboration.

The Soviet scientific apparatus is enormous, complex, and compartmentalised. It is managed by an administration that is centralised and beaurocratic with considerable overlap of interests and responsibilities. In particular there is a certain rivalry between the Academy of Sciences and the State Committee for Science and Technology (GKNT) in fields (e.g. Biotechnology) where they are complementary.

The GKNT is responsible for setting the major guidelines of science and technology progress that form the basis of the 5 Year Plans, for the creation of new scientific centers, and for drawing up a list of research areas and their financing. There are presently five biology projects:

1. The Human Genome.
2. Dangerous Diseases.
3. Food Production by Biotechnology (transgenic animals and plants).
4. Environmental Biotechnology.
5. New Techniques in Biotechnology (cell-free protein synthesis, bioleaching, protein engineering, bioengineering)

The GKNT is also responsible for implementing the science and technology programs of COMECOM members and for the sale of Soviet licences abroad as well as the purchase of licences and prototypes.

The Academy of Sciences is responsible for the planning, direction, co-ordination, and supervision of the National Research Programs in its Institutes as detailed in the 12th Five Year Plan (1986-90). Traditionally the research has been fundamental, but applied research has become more significant as the Academy serves more as the principal vehicle for

transfers to industry. Under a new Chairman it is undergoing considerable reorganisation, particularly in its administration. Biological research is the responsibility of the Chemicotechnological and Biological Sciences section and there is a Council of Biotechnologies within the Academy to consider specific project proposals. Research programs in biotechnology are also carried out in the Research Institutes of the Academy of Medical Sciences and the Academy of Agricultural Sciences.

The Ministry of Higher Education is responsible for the 65 State Universities, the best known being the Lomonosow Moscow State University, which trains the majority of Soviet molecular geneticists. While their main function is to teach, some research is carried out principally in collaboration with Institutes of the Academy of Sciences.

Applied research is carried out within the laboratories of several Industrial Ministries, principally the Ministry of Medical Industry. This Ministry is responsible for the production of SCP, enzymes, and lysine (20% of the worlds production). At present, Interferon 2 is the only genetically engineered product in production (at Vilnyus in Lithuania), but there are up to 15 others under development including other interferons, human growth hormone, and proinsulin.

Of the 21 Interbranch Scientific and Technical Complexes, the MNTK Biogen one deals specifically with Biotechnology. It is subordinate to the Academy of Sciences and the Ministry of Medical Industry, and is based at the Shemykin Institute of the Academy of Sciences. Its aim is to promote technology transfer from the science base to industry and it is a collaborative enterprise involving some 27 Academy and Ministry Institutes. Until 1989 funding came mainly from the member Institutes, but now about 70% of funding will come directly from the GKNT. Funds will be allocated to projects through a peer review system. Unlike the usual Soviet collaborative programs that attempt to bridge the gap between researchers and industry, profit is the stimulus to improvement here. The MNTK enterprises can keep the money made from sales to develop other products, rather than funnel profits to the Government. The association already markets a number of restriction enzymes, and plans to produce a range of rDNA products and laboratory equipment. It hopes to set up joint ventures with foreign companies and has completed field trials on BST in cooperation with Monsanto, who have also spent about $1 million on a joint laboratory. A joint venture with Hoffman-LaRoche to make test kits has also been set up recently.

Dr. Rimmington on Achievements and Prospects of Soviet Biotechnology.

He reports that in terms of bulk output the USSR has

the largest Biotechnology industry in the World, with primary contributions to both Agriculture and Medicine. The Ministry of Medical Industry which has responsibility for industrial biotechnology has over 130 microbiological factories under its wing, possesses a workforce of 192,000 people and in 1988 invested some 643 million Roubles in new production.

Until recently, much of the Soviet effort in industrial biotechnology was directed at the production of SCP which was urgently required to relieve chronic shortages of protein in the country's livestock sector. Huge factories for the production of SCP from n-paraffins are located at Angarsk, Kirishi, Kremenchung, Kstovo, Mozyr, Novopolotsk, Svetloyar, and Syzran. By 1987 total output of SCP had reached 1,690,000 tons. According to Soviet estimates this was equivalent (in terms of protein) to the addition of 8.5-11.8 million tons of grain to the nation's feed supplies.

The USSR has also embarked on the world's most extensive program of biological control of agricultural pests. Currently such methods are being used on more than 19 million hectares of agricultural land in the Soviet Union. As part of this program a signifigant capacity for the production of microbial pesticides has been developed. In 1985 this industry with factories at Berdsk, Stepnogorsk, and Ungeny was producing some 13,000 tons of microbial pesticides, sufficient to treat an area of 2.4 million hectares. These pesticides include those based on bacillus thuringiensis, insecticides based on viruses and fungi, and a bacterial pesticide used in the control of rodents. Other products currently being turned out in significant quantities by Soviet industry include enzymes (9,000 tons in 1987), amino acids (27,000 tons in 1987), antibiotics (1,800 tons in 1987), vitamins and an influenza vaccine.

Thus it appears that the Soviets have been relatively successful in areas where the technology is simple and can be scaled-up with little difficulty. However, the success of Western companies in using more sophisticated biotechnologies to make a major impact on pharmaceuticals production, the food industry, agriculture, waste disposal, etc. has highlighted the growing gap which is developing between the USSR and the developed Western nations in Biotechnology. For example, despite chronic shortages, there has been no serious production of human insulin, a product which has been on the market in the West for six years. Nor is there any sign of the development via biotechnology of the new drugs such as Tissue Plasminogen Activator, new vaccines such as Merck's Hepatitis B vaccine, or other products such as Human Growth Hormone, Interferon alpha 2a or Interferon alpha 2b which have already reached the market in the developed Western countries. This failure to innovate in the biotechnology industry is mirrored in other branches of the Soviet economy.

Now Soviet biotechnology is faced with a problem, the long-term consequences of which could be far more difficult to overcome than the failure to innovate. Wide spread public concern has arisen over biotechnology in the USSR following serious incidents of pollution of SCP factories in Kirishi, Kremenchug, Angarsk, and elsewhere. Biotechnology has quickly lost faith with the public, and is considered to have caused worse damage than the Chernobyl accident. At least 20 Soviet biotechnology plants and construction projects have now been affected in some way or other by public pressure groups and/or environmental protection measures. The Ministry of the Medical and Microbiological Industry which is responsible for biotechnology had to be renamed the Ministry of the Medical Industry in order to remove any reference to microbiology in its title! Several scientists informed the team during the visit that it is now practically impossible to build a new biotechnology plant in the Soviet Union today. One consequence of this is that the Soviets are looking outside the country, both East and West for help to improve and manage their biotechnology facilities.

Despite the public opposition, some new developments are taking place. The new Research and Pilot Plant Center (housing a 40,000 sq ft biotechnological plant and a 40,000 sq ft chemical and pharmaceutical plant) in the Shemyakin Institute of Bioorganic Chemistry will allow new production processes to be scaled up for industry. Another pilot plant has also been built at the USSR Academy of Medical Sciences All-Union Cardiology Research Center where a number of promising drugs are reported to be under development. Other biopharmaceutical factories are also being established by the USSR Academy of Sciences in the Baltic Republics. Finally, the emergence of small co-operative companies (e.g. Alga of Leningrad), which are producing and marketing biotechnological products and the opportunities they present for scientists to receive handsome rewards for their work, also represents a significant development in stimulating innovation in this area.

Information on Soviet Biotechnology

A recent extensive report available in the UK on Soviet Biotechnology is:

Rimmington,A., Biotechnology in the USSR, PhD Thesis, Center for Russian and East European Studies, University of Birmingham, 1988.

Other recent articles include the following:

Maddox, J., Biotechnology's Palace in the Sun, in Nature, vol. 329, No.6142, 29 Oct., 1987.

Sun, M., A Biotech Enterprise Soviet Style, in Science, Vol. 241, 2 Sept., 1988.

Rimmington, A., Biotechnology falls foul of the Environment in the USSR, in Bio/Technology, August, 1989.

An extensive computerised database dedicated to Soviet biotechnology is the CREES Biotechnology Database located at the Center for Russian and East European Studies, University of Birmingham. It holds extensive information on all major Soviet Institutes actively involved in biotechnology research as well as data on over 130 Soviet microbiological factories. News items on biotechnology in the Soviet press are also translated and held on the database. (Chemistry and Biological Sciences Branch)

EUROPEAN SCIENTISTS PARTICIPATE IN ARO SPONSORED WORKSHOP ON "DYNAMIC STABILITY MODELING OF ROTORCRAFT SYSTEMS"

ERO provided support for Professor Marco Borri, Milano Polytechnic, Milano, Italy; Dr. A. Russo, C.A.G. Agusta, Gallarate - Varese, Italy; Professor G. Reichert, Technical University, Braunschweig, West Germany; and Dr. Italo Cafarelli, ONERA, Chatilion, France to attend and participate in an ARO sponsored workshop on "Dynamics and Aeorelastic Stability Modeling of Rotorcraft Systems", held 12-14 March 1990 at Duke University, Durham, N.C. The workshop included the presentation of 33 papers plus a panel discussion. The program was structured into sessions on a) Physical Modeling, b) Aeroelasticity and Stability and, c) Response Dynamics and Control. Approximately 70 participants were at the workshop, including the international participants from France, Italy, Germany and U.K. An overall impression resulting from the workshop was that helicopter technology, especially analytical prediction methods, has strongly improved over the years, but there are still significant problems in the prediction of many phenomena. (Aeronautics and Mechanics Branch).

EUROPEAN SCIENTISTS PARTICIPATE IN ARO SPONSORED WORKSHOP ON UNSTEADY SEPARATION

Five European Scientists, supported by ERO, attended and made presentations at the ARO sponsored workshop on "Analytive Methods in Unsteady Separation". Which was held at the Ohio State University in January 1990. The European Researches were Dr. Susan M. Brown, University College, London, U.K. Professor A. Kluwick, Technical University of Vienna, Austria; Professor N. Riely, University of East Anglia, U.K.; Dr. S. J. Cowley, Imperial College, London, U.K.; and Dr. P.W. Duck, University of Manchester, U.K. The techniques discussed at the workshops were very relevant to the Army helicopter community in obtaining fundamental understanding of dynamic stall and additionally were of interest to

BRL and MICOM researchers because of the importance of unsteady separation to the dynamics of manoeuvring missiles and projectiles. (Aeronautics and Mechanics Branch).

IV. BOARD APPROVED RESEARCH CONTRACTS - FY90

P.I. NAME	INSTITUTION	TITLE	R&D NUMBER
PROF. G. BEN-DOR	BEN GURION UNIVERSITY OF THE NEGEV, ISRAEL	DEVELOPMENT OF A GENERAL ATTENUATION LAW OF NORMAL SHOCK WAVES PROPAGATING INTO DUSTRY GASES	6180-AN
DR. G. KLINGENBERG	FRAUNHOFER-INSTITUT FUR KURZZEITDYNAMIK, GERMANY	FUNDAMENTAL ELECTRICAL IGNITION STUDIES IN REGENERATIVE LP GUN FIXTURES	6362-AN
DR. J.E. FIELD	UNIVERSITY OF CAMBRIDGE, UK	DEFORMATION, FRACTURE AND EXPLOSIVE PROPERTIES OF REACTIVE MATERIALS	6499-AN
PROF. M. BORRI	POLITECNICO DI MILANO, ITALY	COMPOSITE BEAM ANALYSIS	6517-AN
DR. B.S. GREEN	HEBREW UNIVERSITY-HADASSAH MEDICAL CENTER, ISRAEL	CATALYTIC MONOCLONAL ANTIBODIES FOR DECONTAMINATION AND DETECTION OF SULFUR MUSTARD	6308-BC
PROF. F. WILKINSON	LOUGHBOROUGH UNIVERITY OF TECHNOLOGY, UK	MECHANISMS OF LASER INDUCED REACTIONS IN OPAQUE HETEROGENEOUS ENVIRONMENTS	6294-CH
PROF. A.F. DANIL DE NAMOR	UNIVERSITY OF GUILDFORD, UK	THERMODYNAMIKS OF ELECTROLYTE SOLUTIONS FOR USE IN HIGH ENERGY LITHIUM BATTERIES	6376-CH
DR. A. HOLMES-SIEDLE	REM, UK	TO PRODUCE GAMMA RAY DIOSIMETER MOSFETS FOR POCKET RADIAC TO VALIDATE PRODUCTIVITY	6474-CH

IV. BOARD APPROVED RESEARCH CONTRACTS - FY90 CONT/....

P.I. NAME	INSTITUTION	TITLE	R&D NUMBER
DR. J.S. ORR	OCLI OPTICAL COATINGS LTD., UK	DEVELOPMENT OF OPTICAL SWITCHES FOR LASER HARDENING OF INFARED OPTICS	6315-EE
DR. W. JONES	UNIVERSITY OF CAMBRIDGE, UK	SYNTHESIS AND CHARACTERIZATION OF SUPPORTED ELECTRO-OPTICALLY ACTIVE MATERIALS	6404-EE
PROF. A. CONSORTINI	UNIVERSITY OF FLORENCE, ITALY	ANALYSIS OF DATA ON LASER PROP-AGATION THROUGH TURBULENCE	6458-EE
PROF. J.C. DAINTY	IMPERIAL COLLEGE, UK	LIGHT SCATTERING FROM ROUGH SURFACES	6469-EE
DR. J.C. JODOGNE	ROYAL METEOROLOGICAL INSTITUTE, BELGIUM	CONTRIBUTION TO THE EUROCAP PROGRAM FROM THE DOURBES IONO-SPHERIC STATION	6548-EE
DR. L.F. ALBERCA	OBSERVATORI DE L'EBRE, SPAIN	CONTRIBUTION OF EBRE OBSERVATORY TO THE EUROCAP COMMUNICATIONS PROGRAM	6565-EE
DR. B. ZOLESI	INSTITUTO NAZIONALE DI GEOFISICA, ITALY	CONTRIBUTION OF INSTITUTO NAZIONALE DI GEOFISICA TO THE EUROCAP PROGRAM	6566-EE
DR. K. ATTEN-BOROUGH	THE OPEN UNIVERSITY, UK	RESPONSE OF INHOMOGENOUS GROUND TO INSONIFICATION	6268-EN
DR. A. SCHOFIELD	ANDREW N. SCHOFIELD & ASSOCIATES, UK	DEVELOPMENT OF A WES GEOTECHNICAL CENTRIFUGE CENTER, WITH ASSISTANCE IN GEOTECHNICAL COMMISSIONING FROM ANS&A	6396-EN

IV. BOARD APPROVED RESEARCH CONTRACTS - FY90 CONT/....

P.I. NAME	INSTITUTION	TITLE	R&D NUMBER
DR. A. CHISHOLM	CEMP: CENTRE FOR ENVIRONMENTAL MGT & PLANNING, UK	ENVIRONMENTAL ISSUES AFFECTING US ARMY IN US OVERSEAS LOCATIONS	6475-EN
MR. R.H. MARYON	ATMOSPHERIC PROCESSES BRANCH (MET O(P)), UK	EUROPEAN WIND FIELDS FOR LONG RANGE AEROSOL TRANSPORT	6503-EN
DR. H. HANSON	UNIVERSITY OF LUND, SWEDEN	DEVELOPMENT OF A USER'S MANUAL FOR GENESIS (GENERALIZED MODEL FOR SIMULATING SHORELINE CHANGE)	6504-EN
DR. H. APSIMON	IMPERIAL COLLEGE, UK	WORST CASE SCENARIA TO STUDY CONDITIONS UNDER WHICH ATMOSPHERIC AEROSOLS MAY PERSIST AND ACCUMULATE IN THE ATMOSPHERE OVER EUROPE	6505-EN
DR. C.R. THORNE	UNIVERSITY OF NOTTINGHAM, UK	FIELD ASSESSMENT TECHNIQUES FOR BANK EROSION MODELING	6560-EN
PROF. J. LATHAM	UMIST, UK	ACCELERATED EVAPORATION OF LIQUIDS IN ELECTRIC FIELDS	6574-EN
MR. M.H.A. DAVIS	IMPERIAL COLLEGE, UK	DETERMINISTIC METHODS IN STOCHASTIC OPTIMAL CONTROL RESEARCH	6366-MA
DR. J.L. CHERMANT	ISMRA, FRANCE	SEVENTH INTERNATIONAL CONGRESS FOR STEREOLOGY - 7 ICS	5721-MS
PROF. R. REISFELD	HEBREW UNIVERSITY OF JERUSALEM, ISRAEL	A NEW APPROACH TO TUNABLE LASER MATERIAL	5884-MS
DR. B. SHPIGLER	ISRAEL INSTITUTE OF METALS, ISRAEL	VIBRATORY CONTROL OF SHORT FIBERS ORIENTATION IN METAL MATRIX COMPOSITES	5992-MS

IV. BOARD APPROVED RESEARCH CONTRACTS - FY90 CONT/....

P.I. NAME	INSTITUTION	TITLE	R&D NUMBER
DR. P. ROGL	UNIVERSITY OF VIENNA, AUSTRIA	COMPENDIUM OF TERNARY PHASE DIAGRAMS OF METAL-B-NI AND METAL-SI-NI	6091-MS
PROF. J.R. KLEPACZKO	LAB DE PHYSIQUE ET MECANIQUE DES MATERIAUX, FRANCE	EXPERIMENTAL INVESTIGATION OF ADIABATIC SHEAR BANDING AT DIFFERENT IMPACT VELOCITIES	6148-MS
DR. H. SENF	FRAUNHOFER-INSTITUT FUR KURZZEITDYNAMIK (EMI), GERMANY	EXPERIMENTAL INVESTIGATION OF WAVE AND FRACTURE PHENOMENA IN IMPACTED CERAMICS	6472-MS
DR. J.F.V. VINCENT	THE UNIVERSITY OF READING, UK	CATALOGUE OF SENSORY SYSTEMS FROM NATURE	6579-MS
PROF. D.J. CARDIN	UNIVERSITY OF DUBLIN, IRELAND	INVESTIGATE THE SYNTHESIS AND APPLICATIONS OF LARGE HETERO-METALLIC CLUSTER SYSTEMS	6307-PH

V. FY90 CONFERENCES

DATE	P.I. NAME	INSTITUTION	CONFERENCE TITLE	LOCATION	R&D NUMBER
4-6 JAN '90	DR. K. KUNC	UNIVERSITE P.& M. CURIE	TOTAL ENERGY METHODS AND PHYSICS OF III-V SEMICONDUCTORS	PARIS, FRANCE	6230-EE
16-18 JAN '90	DR. R. RESTA	SCULOA INT. SUPEROIRE DI STUDI AVANZATI, ITALY	INTERNATIONAL WORKSHOP ON COMPUTATIONAL CONDENSED MATTER PHYSICS	TRIETE, ITALY	6507-EE
29 JAN-2 FEB '90	DR. T. BRICHETEAU	INRIA	9TH INTERNATIONAL CONFERENCE ON COMPUTING METHODS IN APPLIED SCIENCES AND ENGINEERING	PARIS, FRANCE	6371-MA
16-23 MAR '90	DR. D. CAILLARD	CENTRE D'ELABORATION de MATERIAUX	MECHANISM OF DEFORMATION AND THE STRENGTH OF ADVANCED MATERIALS	AUSSOIS, FRANCE	6321-MS
2-4 APR '90	DR. K. HENRIKSEN	UNIVERSITY OF TROMSO	INTERNATIONAL SYMPOSIUM ON CLIMATES OF THE NORTHERN LATITUDES: PAST, PRESENT, FUTURE	TROMSO, NORWAY	6373-EN
2-6 APR '90	DR. P. ECHLIN	UNIVERSITY OF CAMBRIDGE, UK	4TH INTERNATIONAL MEETING ON LOW TEMPERATURE BIOLOGICAL MICROSCOPY AND ANALYSIS	CAMBRIDGE, UK	6440-BC

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DATE	P.I. NAME	INSTITUTION	CONFERENCE TITLE	LOCATION	R&D NUMBER
16-27 APR '90	PROF. M.V. HEITOR	INSTITUTO SUPERIOR TECNICO	NATO ASI ON COMBUSTING-FLOW DIAGNOSTICS	ALGARVE PORTUGAL	6416-AN
23-27 APR '90	DR. G.M. BROWN	UNIVERSITY COLLEGE OF WALES, UK	XV GENERAL ASSEMBLY OF THE EUROPEAN GEOPHYSICAL SOCIETY	COPENHAGEN, DENMARK	6444-EN
24-27 APR '90	PROF. J. WHITEMAN	BRUNEL UNIVERSITY	7TH CONFERENCE OF FINITE ELEMENTS AND APPLICATIONS	UXBRIDGE, UK	6258-MA
20-25 MAY '90	PROF. M. GOTTLIEB	BEN-GURION UNIVERSITY OF THE NEGEV, ISRAEL	NETWORKS 90	RAMAT RACHEL, ISRAEL	6429-MS
23-25 MAY '90	PROF. M.T. MORA	UNIVERSITAT AUTONOMA DE BARCELONA, SPAIN	THERMODYNAMICS OF ALLOYS	BARCELONA, SPAIN	6379-MS
28-30 MAY '90	DR. A. DANCER	INSTITUTE FRANCO-ALLE MAND de RECHERCHES	SYMPOSIUM ON NOISE-INDUCED HEARING LOSS	BEAUNE, FRANCE	6377-BC
17-21 JUN '90	DR. H. REICHENBACH	FRAUNHOFER-INSTITUT FUR KURZEITDYNAMIK	9TH MACH REFLECTION SYMPOSIUM MRS 9	FREIBURG, GERMANY	6500-AN
18-29 JUN '90	DR. E.N. ECONOMOU	RESEARCH CENTER OF CRETE, GREECE	RELAXATION IN COMPLEX SYSTEMS	HERAKLION, CRETE, GREECE	6432-MS

V. FY90 CONFERENCES CONT/....

DATE	P.I. NAME	INSTITUTION	CONFERENCE TITLE	LOCATION	R&D NUMBER
21-27 JUN '90	PROF. A. LE MEHAUTE	UNIVERSITE DES SCIENCES ET TECHNIQUES de LILLE	INTERNATIONAL CONFERENCE ON CURVES AND SURFACES	CHAMONIX, FRANCE	6367-MA
25 JUN-7 JUL '90	DR. L. PARETTI	INSTITUTE MASPEC DEL CNR	NANOSTRUCTURED MAGNETIC MATERIALS	CRETE, GREECE	6418-MS
2-6 JUL '90	PROF. B.D. SLEEMAN	UNIVERSITY OF DUNDEE	10TH CONFERENCE ON THEORY OF ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS	DUNDEE, SCOTLAND, UK	6411-MA
8-14 JUL '90	PROF. J. JIMINEZ	UNIVERSIDAD POLITECNICA MADRID	THE GLOBAL GEOMETRY OF TURBULANCE	ROTA, SPAIN	6417-AN
8-14 JUL '90	DR. F. KAPPEL	UNIVERSITY OF GRAZ	CONTROL AND ESTIMATION OF DISTRIBUTED PARAMETER SYSTEMS	STYRIA, AUSTRIA	6425-AN
8-14 JUL '90	PROF. A.E. BEYLICH	TECHNISCHE HOCHSCHULE AACHEN GERMANY	SEVENTEENTH INTERNATIONAL SYMPOSIUM ON RAREFIELD GAS DYNAMICS	AACHEN GERMANY	6428-AN
9-12 JUL '90	PROF. D.F.G. DURAO	INSTITUTO SUPERIOR TECHNICO	5TH INTERNATIONAL SYMPOSIUM ON APPLICATIONS OF LASER ANEMOMETRY TO FLUID MECHANICS	LISBON, PORTUGAL	6426-AN

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DATE	P.I. NAME	INSTITUTION	CONFERENCE TITLE	LOCATION	R&D NUMBER
16-20 JUL '90	DR.J.F. GIBSON	ROYAL SOCIETY OF CHEMISTRY, UK	9TH INTERNATIONAL SYMPOSIUM ON ORGANOSILICON CHEMISTRY	LONDON, UK	6434-CH
23 JUL-3 AUG '90	DR. P. KOIDL	FRAUNHOFER INST. ANGEWANDTE FEST-KURPERPHYSIK, GERMANY	DIAMOND AND DIA-MOND-LIKE FILMS	IL CIOCCO, ITALY	6375-MS
22-28 JUL '90	DR. S. DAVIDSON	CITY UNIVERSITY, UK	XIIITH IUPAC SYM-POSIUM ON PHOTO-CHEMISTRY	COVENTRY, UK	6441-CH
23 JUL-4 AUG '90	PROF. C. JACOBONI	UNIVERSITY OF MODENA, ITALY	NATO-ASI: PHYSICS OF GRANULAR NONOELECTRONICS	LUCCA, ITALY	6455-EE
27-31 JUL 90	DR. A.B. POOLE	QUEEN MARY AND WESTFIELD COLLEGE, UK	9TH INTERNATIONAL CONFERENCE ON ALKALI AGRREGATE REACTION IN CONCRETE	LONDON, UK	6397-EN
30 JUL-3 AUG '90	DR. P.L.F. HEMMENT	UNIVERSITY OF SURREY, UK	INTERNATIONAL CON-FERENCE ON ION IMPLANTATION TECHNOLOGY (III90)	GUILDFORD, SURREY, UK	6461-EE
30 JUL-10 AUG '90	PROF. J. MARSH	UNIVERSITY OF GLASGOW	NATO ASI IN WAVE-GUIDE OPTOELEC-TRONICS	GLASGOW, SCOTLAND, UK	6414-EE

V. FY90 CONFERENCES CONT/....

DATE	P.I. NAME	INSTITUTION	CONFERENCE TITLE	LOCATION	R&D NUMBER
27-31 AUG '90	PROF. A.H. CARDON	VRIJE UNIVERS-ITEIT BRUSSLES, BELGIUM	DURABILITY OF POLY-MER BASED COMPOSITE SYSTEMS FOR STRUCT-URAL APPLICATIONS (ANALYSIS AND PREDICTION)	BRUSSELS, BELGIUM	6183-MS
4-7 SEP '90	PROF. D. DOWSON & DR. C.M. TAYLOR	UNIVERSITY OF LEEDS	17TH LEEDS-LYON SYMPOSIUM ON TRIBOLOGY	LEEDS, UK	6415-AN
23-27 SEP '90	PROF. F. HUCHO	FREIE UNIVERSITAT BERLIN, GERMANY	THE CHOLINERGIC SYNAPSE		6522-BC
24-27 SEP '90	MR. B.L.M. WILSON	PLESSEY RESEARCH & TECHNOLOGY, UK	17TH INTERNATIONAL SYMPOSIUM ON GALLIUM ARSENIDE AND RELATED COMPOUNDS	UK	6529-EE
24-28 SEP '90	DR. C. TROYANOWSKY	SOCITE FRANCAISE DE CHIMIE, FRANCE	THE LIVING CELL IN ITS FOUR DIMEN-SIONS - 47TH INTERNATIONAL MEETING OF PHYSICAL CHEMISTRY	GIF SUR YVETTE, FRANCE	6447-BC
24-28 SEP '90	DR. P. BILLI	UNIVERSITY OF FIRENZE, ITALY	3RD INTERNATIONAL WORKSHOP ON GRAVEL-BED RIVERS: DYNAMICS OF GRAVEL-BED RIVERS	FLORENCE, ITALY	6510-EN

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DATE	P.I. NAME	INSTITUTION	CONFERENCE TITLE	LOCATION	R&D NUMBER
1-5 OCT '90	PROF. R. JELTSCH	ANGEWANDTE MATHEMATIK, SWITZERLAND	3RD JOINT EUROPE-US SHORT COURSE ON HYPERSONICS CONF.	AACHEN, GERMANY	6533-AN
3-5 OCT '90	PROF. S. MISBAH DEEN	UNIVERSITY OF KEELE, UK	A WORKING CONFERENCE ON COOPERATING KNOWLDGE BASED SYSTEMS		6453-CC
29-31 OCT '90	MRS. B. O'DONOGHUE	INSTITUTION OF CIVIL ENGINEERS, UK	THE US STRATEGIC HIGHWAY RESEARCH PROGRAM	KEELE, UK	6506-EN
21-24 APR '91	PROF. M. PESSA	UNIVERSITY OF TECHNOLOGY, FINLAND	6TH EUROPEAN CONFERENCE ON MOLECULAR BEAM EPITAXY, EURO MBE-91		6403-EE

VI. FY90 WORKSHOPS

DATE	P.I. NAME	INSTITUTION	TITLE	LOCATION	R&D NUMBER
26-28 MAR '90	PROF. D. BLOOR	UNIVERSITY OF DURHAM	PROGRESS TOWARDS MOLECULAR SCALE ELECTRONICS	DURHAM, UK	6332-CH
26-28 MAR '90	DR. D. MAYSTRE	LAB, D'OPTIQUE ELECTROMAGNETIQUE FRANCE	WORKSHOP ON "RECENT PROGRESS IN SURFACE AND VOLUME SCATTERING	MARSEILLE, FRANCE	6236-EE
18-23 JUN '90	PROF. R.F. BISHOP	UMIST, UK	XIV INTERNATIONAL WORKSHOP ON CONDENSED MATTER THEORIES	ELBA, ITALY	6479-PH
24-29 JUN '90	DR. J. BAR-TOV	ISRAEL MINISTRY OF DEFENCE, ISRAEL	U.S.-ISRAEL RESEARCH CONFERENCE ON THE ADVANCES IN APPLIED BIOTECHNOLOGY	ISRAEL	6438-BC
2-3 JUL '90	PROF. J.H. WHITELAW	IMPERIAL COLLEGE	UNSTEADY FLOWS	LONDON, UK	6314-AN
2-4 JUL '90	PROF. B.L. WEISS	UNIVERSITY OF SURREY	MULTIQUANTUM WELL MIXING FOR OPTICAL DEVICES	COMO, ITALY	6343-EE
6-8 SEP '90	PROF. D. MAYSTRE	UNIVERSITY OF MARSEILLE	MODERN ANALYSIS OF SCATTERING PHENOMENA	MARSEILLE,	6236-EE
24-25 SEP '90	DR. A. SOLOMON	THE OPEN UNIVERSITY, UK	FRONTIERS OF CONDENSED MATTER PHYSICS: THE UK PERSPECTIVE	MANCHESTER, UK	6509-PH

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	DR. B. NOBLE	BRUNEL UNIVERSITY OF WEST LONDON, UK	LIAISON VISITS TO US LABORATORIES RE: EFFICIENT USE OF SOME CURRENT SCIENTIFIC COMPUTER SOFTWARE, EG. MATLAB & MATHEMATICA		6490-MA

VII. CONTRACT REPORTS RECEIVED

AUTHOR(S)	TITLE	TYPE OF REPORT
R.M. PEREZ, M.C. SCHMIDT & J.H. WHIRELAW	WALL HEAT TRANSFER MEASUREMENTS IN A HIGH SPEED GUN SIMULATOR	5TH INTERIM (588-AN-01)
G. KLINGENBERG & H. ROCKSTROH	INVESTIGATION OF HIGHLY PRESSURIZED TWO PHASE, RE-ACTING FLOW	5TH INTERIM (5708-AN-01)
G. KLINGENBERG	ELECTRICAL IGNITION OF HAN-BASED LIQUID PROPELLANTS	FINAL (5329-AN-01)
F.B. CARLETON, K. KRALLIS & F.J. WEINBERG	LASER INITIATED IGNITION OF LIQUID PROPELLANT	6TH INTERIM (5462-AN-01)
N.V. HEITOR	CONFERENCE ON COMBUSTING FLOW DIAGNOSTICS - NATO ASI 16-27 April '90, Algarve, Portugal	PRE-CONF LIT (6416-AN-02)
A.F. ALLISTON-GREINER, J.A. GREENWOOD, D. CAMERON & A. CAMERON	BASIC MECHANISM OF DIESEL LUBRICATION CORRELATION OF BENCH AND ENGINE TESTS	DRAFT FINAL (5003-AN-01)
C. FORSTER & R.L. ELDER	RADIAL INFLOW TURBINE STUDY	2ND INTERIM (5824-AN-01)
J.E. FIELD	DEFORMATION, FRACTURE AND EXPLOSIVE PROPERTIES OF REACTIVE MATERIALS	FINAL (6112-AN-01)
G. BINDER	EXPERIMENTAL INVESTIGATION OF RETARDED UNSTEADY TURBULENT BOUNDARY LAYERS	6TH INTERIM (4922-AN-01
R.M. PEREZ, M.C. SCHMIDT & J.H. WHITELAW	WALL HEAT TRANSFER MEASUREMENTS IN A HIGH SPEED GUN SIMULATOR	6TH INTERIM (5888-AN-01)
H.A. SPIKES	INFRARED STUDY OF PISTON RING TEMPERATURES IN A FIRED ENGINE	2ND INTERIM (6102-AN-01)

VII. CONTRACT REPORTS RECEIVED (Cont/...)

AUTHOR(S)	TITLE	TYPE OF REPORT
H. REICHENBACH & K.O. OPALKA	AN OPTICAL STUDY OF THE FLOW START UP PROCESS IN FOUR CONVERGENT-DIVERGENT NOZZLES	FINAL (6229-AN-01
Y. BIRK & S.W. APPLEBAUM	PROTEASES OF STORED PRODUCT INSECTS AND THEIR INHIBITION BY SPECIFIC PROTEASE INHIBITORS FROM SOYBEANS AND WHEAT GRAIN	FINAL (5383-BC-01)
R. KASINATHAN	ISOLATION, PURIFICATION AND CHARACTERIZATION OF TOXIN FROM SNAIL CONUS	2ND INTERIM (6273-BC-01)
D. LANCET	IDENTIFICATION AND MOLECULAR CLONING OF OLFACTORY RECEPTOR PROTEINS	5TH INTERIM (5926-BC-01)
D. KAMELY, G.S. OMENN & A. CHAKRABARTY	BIOTECHNOLOGY AND BIODEGRADATION	CONF PRO (6192-BC-03)
A. DANCER	IVTH INTERNATIONAL CONFERENCE ON EFFECTS OF NOISE ON THE AUDITORY SYSTEM 28-30 May '90, Beaune, France	PRE-CONF LIT
F.C. DE SCHRYVER	ADSORPTION, MOBILITY AND ORGANIZATION OF ORGANIC MOLECULES AT CLAY SURFACES PROBED BY PHOTOPHYSICS AND PHOTOCHEMISTRY	FINAL (5607-CH-01)
D. BLOOR	INTERNATIONAL WORKSHOP ON PROGRESS TOWARDS MOLECULAR SCALE ELECTRONICS 25-28 March '90, Durham, UK	PRE-CONF LIT (6332-CH-03)
M.H. ABRAHAM & G.S. WHITING	A NEW METHOD FOR THE CHARACTERIZATION OF SOLUTES AND SOLVENT PHASES USING SOLVATOCHROMIC PARAMETERS	6TH INTERIM (5390-CH-01)
M. GRATZEL	CATALYTIC AGENT DEGRADATION ON OXIDE FILMS AND IN MICRO-HETEROGENEOUS SOLUTION SYSTEMS	1ST INTERIM (6305-CH-01)

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AUTHOR(S)	TITLE	TYPE OF REPORT
A. AMIRON	MOLECULAR IONIZATION AND DISSOCIATIVE IONIZATION AY HYPOTHERMAL SURFACE SCATTERING	1ST & 2ND INTERIM (6089-CH-01)
M.F.A. DOVE, N. LOGAN & J.P. MAUGER	CORROSION OF ALUMINIUM ALLOYS BY IRFNA	2ND INTERIM (6286-CH-01)
A.K. JONSCHER, M.A. BARI & N. SIDDIQUI	DIELECTRIC SPECTROSCOPY OF SEMICONDUCTORS	6TH INTERIM (5119-EE-01)
J.C. DAINTY	ENHANCED BACKSCATTERING FROM ROUGH SURFACES	6TH INTERIM (5830-EE-01)
M. PEPPER	PHYSICS RELATED TO FUTURE ELECTRONIC DEVICES	3RD INTERIM (5940-EE-01)
J.O. WILLIAMS, L.E. DAVIS, R.W. MUNN, J.H.R. CLARKE, & T.A. KING	MOLECULAR FILMS FOR OPTO-ELECTRONICS	1ST INTERIM (6290-EE-01)
B. HENDERSON	LASER SPECTROSCOPY OF QUANTUM WELL AND SUPER LATTICE STRUCTURES	5TH INTERIM (5782-EE-01)
K. KUNC	TOTAL ENERGY METHODS AND PHYSICS OF III-V SEMICONDUCTORS - RESEARCH WORKSHOP 4-6 Jan '90	INF.CONF.PROC. (6230-EE-02)
A. VECHT	THE PREPARATION OF ACEL THIN FILMS	5TH INTERIM (5910B-EE-01)
D. MAYSTRE	INTERNATIONAL WORKSHOP ON MODERN ANALYSIS OF SCATTERING PHENOMENA 5-8 Sep '90	PRE-CONF LIT (6236-EE-03)
P. DEMEESTER	NAVAL OPTOELECTRONIC DEVICES BASED ON GaAs AND InP ON Si	1ST INTERIM
J. MARSH	GLASGOW SUMMER SCHOOL ON WAVEGUIDE OPTOELECTRONICS 30 July - 10 August '90	PRE-CONF LIT (6414-EE-02)

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AUTHOR(S)	TITLE	TYPE OF REPORT
H. THIM	A PLANAR MMIC COMPATIBLE TRANSFERRED ELECTRON DEVICE FOR MILLIMETRE WAVE OPERATION	FINAL (5302-EE-01)
P. HEMMENT	INTERNATIONAL CONFERENCE ON ION IMPLANTATION TECHNOLOGY 30 July - 3 August '90, University of Surrey	PRE-CONF LIT (6461-EE-02)
J. DEARING	VTH INTERNATIONAL SYMPOSIUM ON PALAESLUMINOLOGY	ABSTRACTS (6176-EN-02)
B. CLARK	ENVIRONMENTAL POLICY ISSUES AFFECTING THE UNITED STATES ARMY IN ITS OVERSEAS ACTIVITIES	INF WORKSHOP PROC. (6302-EN-03)
M. LARSON	VERIFICATION OF THE PROFILE RESPONSE SIMULATION MODEL SBEACH	FINAL (6285-EN-09)
A. GRUEN	ON-LINE POSITIONING WITH SINGLE FRAME CAMERA DATA	3RD INTERIM (5366-EN-01)
P.A. CARLING	PARTICLE DYNAMICS AND GRAVEL STREAM BED ADJUSTMENTS	1ST INTERIM (6185-EN-01)
M.F. MASUCH	PATTERN RECOGNITION USING NEURAL NETWORKS - OPTIMAL TESTING OF PERCEPTRONS	3RD INTERIM (6037-EN-01)
R.P. PEARCE	CO-ORDINATION OF MESOSCALE METEOROLOGICAL RESEARCH BETWEEN ASL AND EUROPEAN GROUPS	1ST INTERIM (6323-EN-01)
K. ATTENBOROUGH, D.L. BERRY & YU CHAN	ACOUSTIC SCATTERING BY NEAR SURFACE INHOMOGENEITIES IN POROUS MEDIA	FINAL (5260-EN-01)
K.M. SAMBLES & M.G. ANDERSON	SNOWMELT FORECASTING	1ST INTERIM (6194-EN-01)
K.J. SHETH	INFORMATION TECHNOLOGIES FOR THE 90'S ENERGY, ELECTRONICS COMPUTERS AND TELE-COMMUNICATIONS (TENCON '89) 22-24 Nov 89, Bombay, India	INF.CONF.PROC. (6365-MA-02)

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AUTHOR(S)	TITLE	TYPE OF REPORT
P.L. LIGION	ANALYSIS, CONTROL AND FILTERING OF SYSTEMS FROM PHYSICS AND ENGINEERING	5TH INTERIM (5801-MA-01)
A. BRANDT	MULTILEVEL OPTIMIZATION AND ARTIFICIAL INTELLIGENCE	3RD INTERIM (5933-MA-01)
O. OPITZ	CONCEPTUAL AND NUMERICAL ANALYSIS OF DATA 10-12 Apr 89, Augsburg, Germany	CONF. PROC. (6131-MA-02)
T. BRICHETEAU	9TH INTERNATIONAL CONFERENCE ON COMPUTING METHODS IN APPLIED SCIENCE AND ENGINEERING 29 Jan-2 Feb 90, Paris, France	INF.CONF.PROC. (6371-MA-02)
J. WHITEMAN	"MAFELAP 90'" - THE MATHEMATICS OF FINITE ELEMENTS AND APPLICATIONS	PRE-CONF LIT (6258-MA-02)
E. PARDOUX	NONLINEAR FILTERING AND APPROXIMATION TECHNIQUES	1ST INTERIM (6271-MA-01)
J.R. WHITEMAN	USE AND ANALYSIS OF FINITE ELEMENTS METHODS FOR PROBLEMS OF SOLID MECHANICS AND FRACTURE	2ND INTERIM (6078-MA-01)
M.R. BATHE & K.R. McNAUGHT	DEVELOPMENT OF A COMBAT MODEL WITH A MINIBATTLE STRUCTURE	FINAL (6036-MA-01)
V. SCHUMACHER	EUROPEAN CONFERENCE ON ADVANCED MATERIALS AND PROCESSESS, EUROMAT '89 22-24 Nov 89, Aachen, Germany	INF.CONF.PROC. (6355-MS-02)
D.K. DAS-GUPTA	FAST ACTING OPTICAL BEAM DEFLECTION SYSTEM	FINAL (5821-MS-01)
P. ROGL & J. SCHUSTER	BORONNITRIDE AND SILICONNITRIDE SYSTEMS	1ST INTERIM (6092-MS-01)
J. BERNSTEIN, J.Y. BECKER, & S.S. SHAIK	ELECTRICALLY CONDUCTING ORGANIC MATERIALS; DESIGN, SYNTHESIS AND CHARACTERIZATION	5TH INTERIM (5618-MS-01)

VII. CONTRACT REPORTS RECEIVED (Cont/...)

AUTHOR(S)	TITLE	TYPE OF REPORT
D. CAILLARD	CONFERENCE ON MECHANISMS OF DEFORMATION AND STRENGTH OF ADVANCED MATERIALS 16-23 Mar '90, Aussois, France	PRE-CONF LIT. (6321-MS-02)
D. AVNIR	THE SOL GEL etc.	2ND INTERIM (5548-MS-01)
A.J. KINLOCH, B. BLACKMAN &	THE ENVIRONMENTAL AND IMPACT RESISTANCE OF ADHESIVELY BONDED THERMOPLASTIC FIBRE COMPOSITES	2ND INTERIM (6266-MS-01)
Y. BEN-ARYEH	CO-OPERATIVE EFFECTS AND INTINSIC OPTICAL BI-STABILITY IN COLLECTIONS OF ATOMS	FINAL (5859-PH-01)
D.M. ROWE	PRELIMINARY INVESTIGATION INTO THE EFFECT OF HIGH TEMPERATURE THERMAL ANNEALS ON THE FIGURE OF MERIT OF SILICON GERMANIUM ALLOYS	FINAL (6106-PH-01)
S. & H. SCHERRER	IMPROVEMENT STUDY OF DISILIADE THERMOELECTRIC MATERIALS	FINAL (6287-PH-09)
R. CAR & E. TOSATTI	ELECTRONIC AND ATOMIC STRUCTURE OF SEMICONDUCTORS AND HIGH Tc SUPERCONDUCTORS	1ST INTERIM (6280-PH-01)

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